MICROBIAL DIVERSITY: a Summer Course at the Marine Biological Laboratory, Woods Hole, MA

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"Microbial Diversity" is an intensive 6.5-week lecture and laboratory-based course designed for graduate students, postdoctoral fellows and established investigators. The value of the course lies in its historical success in training scientists to recognize and take advantage of the incredible metabolic diversity of microbes as a means of generating fundamental and applied knowledge. Over the years, this internationally recognized course has trained many of today's leading microbiologists and is commonly cited as a "life-changing" event by course participants.

The Microbial Diversity course takes advantage of the diverse natural environments found near Woods Hole: microbial mats in salt water marshes, anaerobic communities in freshwater bogs, pelagic and benthic communities in marine ecosystems, and the many marine animals and plants that harbor microbial symbionts. The sheer magnitude of this natural diversity provides ample opportunities for participants with minor or extensive prior experience in microbiology to discover and study novel microbes. Participants learn both classical and contemporary methods to isolate and cultivate microbes, including anaerobes and the primary producers in many environments - photosynthetic microbes.

Progress in the last year. The Microbial Diversity 2003 course at the Marine Biological Laboratory took place from June 15 to August 1, 2003. The nineteen students who comprised the course included 11 from American institutions, as well as students from Israel, Switzerland, Germany, Peru and Denmark. One of the students is a faculty member at the University of Cincinnati. In addition, seventeen students are doctoral students with one student a master's degree candidate. There are 9 men and 10 women. A list of the students and their affiliations and as well as lists of the Microbial Diversity course faculty, staff and lecturers is attached. The resident faculty were the co-directors of the course: Caroline Harwood (University of Iowa) and Alfred Spormann (Stanford University) as well as Jane Gibson from Cornell University and

Terrance Marsh from Michigan State University. An excellent staff of six graduate students and postdoctoral fellows assisted the faculty. Tom Schmidt of Michigan State University served as the Course Director designee. In 2004 he and William Metcalf of the University of Illinois will begin their term as the new Course Directors, continuing the rich tradition of excellence in this course.

The students, faculty and staff worked and studied intensively for six-and-a-half-weeks. Our common aim was to become competent in microbiological techniques for working with a broad range of microbes, and in approaches for recognizing the metabolic, phylogenetic and genomic diversity of cultivated and as yet uncultivated bacteria.

The students isolated and cultivated characteristic microbial types from various marine, fresh water, animal, and plant habitats and they initiated individual research projects with selected isolates. Emphasis was placed on the isolation and cultivation of organisms that are distinguished by their physiological, biochemical, and morphological properties. Techniques for cultivation of strict anaerobes were particularly emphasized. Examples of some of the microbial types that the students isolated are methanogens, acetogens, sulfate-reducing anaerobes, fermentative anaerobes and phototrophs, as well as bacteria involved in the geochemical cycling of various metals. Magnetic bacteria, sulfur-oxidizing bacteria, spirochetes and luminescent-bacteria were also studied.

We also investigated strategies that microbes use to compete successfully in nature. Bacterial biofilms, chemotaxis and quorum sensing were studied. A laboratory component on molecular approaches to microbial diversity instructed students to use approaches of molecular phylogeny and comparative genomics. This involved the isolation and amplification of 16S rRNA genes as phylogenetic markers and the use of computer software programs to analyze nucleic acid sequences and to construct phylogenetic trees. We also included a laboratory exercise on fluorescent in-situ hybridization (FISH).

The laboratory component was complemented by an extensive series of lectures describing the physiology, biochemistry, and evolutionary relationships of a variety of bacteria. We also discussed molecular methods to study microbial ecology. Lectures on microbial phylogeny and genomics were also given. The course hosted 21 visiting lecturers, 7 of whom spoke in three minisymposia. For 2003, these minisymposia covered the topics of: "Bacterial Communication", "Microbial Communities", and "Microbial Evolution". In previous years, these minisymposia covered the topics of: "Microbial Communities", "Bacterial Methane Production and Utilization" and "Cyanobacterial Genomics.

Formal laboratory exercises occupy most of the students' research time during the first three weeks and then taper off as they start their own research projects. Attached to this report is a listing of the student projects undertaken during the summers of 2001 – 2003.

The following table reflects the diversity of the applicant pool and the student body. Also included with this report is a listing of the faculty from the years 2001 – 2003.

Table 1: Diversity of the applicant pool and student body

	APPLICANTS				ADMITTED			
Year	Female	Male	Minority	Foreign	Female	Male	Minority	Foreign
2003	19	17	1	16	10	9	0	8
2002	23	22	2	22	10	10	1	8
2001	21	19	1	18	8	12	1	8
TOTALS	63	58	4	56	28	31	2	24

For the years 2000 – 2003, admitted students represented the following countries: Argentina, Australia, Belgium, Canada, Colombia, Denmark, Germany, India, Israel, Peru, Russia, Singapore, Switzerland, Taiwan and the UK.

Applications were received from students from the following countries: Argentina, Australia, Belgium, Brazil, Canada, Chile, Columbia, Cyprus, Denmark, Finland, Germany, Ghana, India, Israel, Italy, Kenya, Mexico, Netherlands, Nigeria, Peru, PR China, Romania, Russia, Singapore, Spain, Taiwan and the UK.

1) Microbial Diversity Class Lists

2003

Anderson, Christine, Scripps Institution of Oceangraphy
Cadillo-Quiroz, Hinsby, Cornell University
Costello, Elizabeth, University of Colorado at Boulder
Daprato, Rebecca, Rice University
DeAngelis, Kristen, University of California, Berkeley
Dubinsky, Eric, University of California
Gescher, Johannes, Universität Freiburg
Lever, Mark, University of North Carolina, Chapel Hill
Martens-Habbena, Willm, University of Oldenburg
McCarren, Jay, Scripps Institution of Oceanography
Oerther, Daniel, University of Cincinnati
Petersen, Dorthe, Goteborg University
Poretsky, Rachel, The University of Georgia
Sudek, Sebastian, Scripps Institution of Oceanography
Teitzel, Gail, Northwestern University
Tobler, Nicole, EAWAG/ETH

2002

Boucher, Yan, Dalhousie University
Case, Rebecca, University of New South Wales
Clement, Barbara, Doane College

Denef, Vincent, Ghent University
Dethlefsen, Les, Michigan State University
Dick, Gregory, Scripps Institution of Oceanography
Erbs, Marianne, EAWAG
Gentile, Margaret, Stanford University
Ginder-Vogel, Matthew, Stanford University
Graco, Michelle, University of Pierre et Marie Curie
Harrison, Faith, University of Iowa
Koren, Omry, Tel Aviv University
Lostroh, Phoebe, University of Iowa College of Medicine
Maresca, Julie, Pennsylvania State University
Pinel, Nicolas, University of Washington
Rajagopal, Soumitra, University of Nebraska
Remold Susanna, Michigan State University
Sharp, Katherine, Scripps Institution of Oceanography
Spain, Jim, United States Air Force
Walker, Jeffrey, University of Colorado

2001

Baumgartner, Laura, University of Connecticut
Behrens, Sebastian, Max-Planck-Institute for Marine Microbiology
Coby, Aaron, Indiana University
Fleming, Erich, University of Oregon
Gerlach, Robin, Montana State University
Giegerich, Jennifer, Pennsylvania State University
Harris, Jonathan, University of Colorado, Boulder
Hughes, Jennifer, Brown University
Kellogg, Laurie, University of Notre Dame
Kelman, Dovi, Tel Aviv University
Lim, Grace, Scripps Institution of Oceanography
Lupp, Claudia, University of Hawaii
Martiny, Adam, Technical University of Denmark
Pilcher, Carl, National Aeronautics & Space Administration Headquarters
Rash, Brian, Louisiana State Unversity
Reed, Andrew, Rutgers University
Riemann, Lasse, Scripps Institution of Oceanography
Robidart, Julie, Scripps Institution of Oceanography
Schuster, Martin, University of Iowa
Whitaker, Rachel, University of California, Berkeley

2) Microbial Diversity Course Faculty and Staff

2003

Course Directors

Harwood, Caroline, University of Iowa
Schmidt, Tom, Michigan State University
Spormann, Alfred, Stanford University

Course Faculty & Lecturers

Bassler, Bonnie, Princeton University
Behrens, Sebastian, MPI for Marine Microbiology

Chisholm, Penny, Massachusetts Institute of Technology
Edwards, Katrina, Woods Hole Oceanographic Institute
Gibson, Jane, Cornell University (Emerita)
Handelsman, Jo, University of Wisconsin
Harrison, Faith, University of Iowa
Kappler, Andreas, California Institute of Technology
Leadbetter, Jared, California Institute of Technology
Lory, Stephen, Harvard Medical School
Lovley, Derek, University of Massachusetts
Marsh, Terence, Michigan State University
Martiny, Adam, BioCentrum-DTU
McCarter, Linda, University of Iowa
McFall-Ngai, Margaret, University of Hawaii
Moran, Mary Ann, University of Georgia
Mueller, Jochen, Stanford University
OToole, George, Dartmouth Medical School
Pace, Norm, University of Colorado
Ruby, Edward, University of Hawaii
Sockett, Liz, University of Nottingham
Wade, Brian, Arizona State University
Waterbury, John B, Woods Hole Oceanographic Institution
Wolfe, Ralph, University of Illinois (Emeritus)

2002

Course Directors

Harwood, Caroline, University of Iowa
Spormann, Alfred, Stanford University

Course Faculty & Lecturers

Behrens, Sebastian, MPI for Marine Microbiology
Boetius, Antje, MPI fur Marine Mikrobiologie
Breznak, John, Michigan State University
Buckley, Daniel, University of Connecticut
Delong, Edward, Monterey Bay Aquarium
Elhai, Jeff, Virginia Commonwealth Univ.
Gibson, Jane, Cornell University (emerita)
Giovannoni, Stephen, Oregon State University
Gottschalk, Gerhard, Inst. fur Mikrobiologie u Genet
Handelsman, Jo, University of Wisconsin
Larimer, Frank, Oak Ridge National Laboratory
Lory, Stephen, Harvard Medical School
Loveley, Derek, University of Massachusetts
Marsh, Terence, Michigan State University
Martiny, Adam, BioCentrum - DTU
Meeks, John, University of California
Metcalf, William, University of Illinois
Mueller, Jochen, Stanford University
Rocap, Gabrielle, University of Washington
Schaefer, Amy, University of Iowa
Strous, Marc, University of Nymegen
Thauer, Rudolf, MPI fur Terrestr. Mikro

Wackett, Lawrence, University of Minnesota
Wolfe, Ralph, University of Illinois

2001

Course Directors
Harwood, Caroline, University of Iowa
Spormann, Alfred, Stanford University

Course Faculty & Lecturers
Armitage, Judith, University of Oxford
Brahamsha, Bianca, University of California, San Diego
Buckley, Daniel, University of Connecticut
DeLong, Edward, Monterey Bay Aquarium Research Institute
Ditty, Jayna, Texas A&M University
Forney, Larry, University of Idaho
Gerlt, John A., University of Illinois
Gibson, Jane, Professor Emeritus
Golden, Susan, Texas A&M University
Golden, James W., Texas A&M University
Larimer, Frank W., Oak Ridge National Laboratory
LaRossa, Robert, E.I. Du Pont de Nemours and Company
Lory, Steve, Harvard Medical School
Lovley, Derek, University of Massachusetts
Margulis, Lynn, University of Massachusetts
Mueller, Jochen, Stanford University
Palenik, Brian, University of California, San Diego
Pelletier, Dale, Stanford University
Schaefer, Amy, University of Iowa
Schmidt, Thomas, Michigan State University
Weinstock, George, Baylor College of Medicine

3) Microbial Diversity Class Projects

2003

Kristen DeAngelis, University of California
Quorum Scenting or Do bacteria exist that can chemotax towards acyl-homoserine lactones?

Rebecca C. Daprato, Rice University
A Tale of Two (Anaerobic Mixed Halorespiring) Cultures: Who's There?

Eric Dubinsky, University of California
Isolation of Fe(III)-reducing Aeromonas species from a freshwater marsh in Woods Hole, MA

Daniel B. Oerther, University of Cincinnati
Molecular Evidence for a Novel Lineage of Ammonia Oxidizing Beta-subclass Proteobacteria

Sybille Zitzmann, MPJMM, Bremen, Germany
Initial Biofilm Formation

Jay McCarren, Scripps Inst. Of Oceanography
Investigating the effect of motility on bacterial predation by a heterotrophic nanoflagellate

Elizabeth Costello, University of Colorado
Stalking the Wild Crenarchaeote: A fluorescence in-situ hybridization (FISH) microscopic search

Helen K. White, Woods Hole Oceanographic Inst.
Investigations into the Persistence of Petroleum Contamination in Marsh Sediments and the Associated Microbial Community

Gil Zeidner, Technion, Haifa, Israel
Dynamics of microbial community in the marine sponge Holichondria sp.

Sebastian Sudek, Scripps Inst. Of Oceanography
The Berries - revisited

Hinsby Cadillo-Quiroz, Cornell University
Vertical distribution of aerobic CH4 consumption in cedar swamp soil: NH4 implications.

Johannes Gescher, Frieburg University
Comparison of the abundance of the different benzoate degradation pathways and short stories about enrichments on Isopropanol, Mandelonitrile, and Boc-Methionine

Gail M. Teitzel, Northwestern University
Community structure: environmental biofilms and purple non-sulfur bacteria

Dorthe Groth Petersen, Nat'l Environmental Research Inst., Denmark
Competition between two isolates of marine p-hydroxybenzoate degrading bacteria

Rachel S. Poretsky, The University of Georgia
Finding a niche: The habits and habitats of purple non-sulfur bacteria

Christine Anderson, Scripps Inst. Of Oceanography
Isolation, Growth and Investigation of the Bacterial Epibiont of the Heterocysts of an Anabaena sp.

Nicole Tobler, EAWAG, Switzerland
Iron Reduction in Freshwater and Saltwater Environments

Willm Martens-Habbena, University of Oldenburg
Novel attempts to cultivate abundant microbes from marine surface water at Buzzards Bay, Woods Hole, MA

Mark Lever, University of North Carolina
Cultivation Experiments with Anaerobic Anoxygenic Phototrophic Iron Oxidizing Bacteria

2002

Yan Boucher, Dalhousie University
Rebecca Case, University of South Wales

Vincent Denef, Ghent University
The quest for Daptobacter

Barbara Clement, Doane College
Michelle Graco, University of Pierre et Marie Curie
Nick Pinel, University of Washington
No bug is an island : the messy business of working with co-cultures

Les Dethlefsen, Michigan State University
Discoveries and observations among the purple nonsulfur bacteria

Gregory Dick, Scripps Institution of Oceanography
Molecular tracking of iron and manganese-reducing enrichments

Marianne Erbs, EAWAG
Jim Spain, United States Air Force
Iron metabolism in natural environments

Margy Gentile, Stanford University
The green berries

Koty Sharp, Scripps Institution of Oceanography
The purple berries

Matt Grinder-Vogel, Stanford University
Omry Koren, Tel Aviv University
Community structure: from the environment to the lab.

Phoebe Lostroh, University of Iowa College of Medicine
DNA eaters

Faith Harrison, University of Iowa
Chemotaxis in Clostridia

Julie Maresca, Pennsylvania State University
Jeff Walker, University of Colorado
Aerobic anxoygenic phototrophs: photon pirates of the sea.

Sumit Rajagopal, University of Nebraska
ClpB as an environmental monitor.

Susie Remold, Michigan State University
Triclosan resistance in environmental isolates.

2001

Laura Baumgartner, University of Connecticut
Metabolic interactions between a purple sulfur bacterium and a facultative anaerobe

Sebastian Behrens, MPI for Marine Microbiology, Bremann Germany
Characterization of community structure and composition of microbial biofilms forming a trickling filter bioreactor.

Aaron Coby, Indiana University
Heavy metal tolerant bacteria as bioindicators of metal contamination

Erich Fleming, University of Oregon
The effects of saturating levels of ammonia and nitrate on the recovery of a microbial mat from a common physical disturbance.

Robin Gerlach, Montana State University
Attempted enrichment of Cr(III) oxidizing bacteria

Jen Giegerich, Penn State Univ.
Attempt to gain information on the host-associated spirochete Cristispira..

Kirk Harris, University of Colorado
Microscopic analysis of sulfate reducing bacterial consortia.

Jen Hughes, Brown University
Formation of biofilms by purple nonsulfur bacteria

Laurie Kellogg, University of Notre Dame
What not to do: or, how I learned to love microbiology.

Dovi Kelman, Tel Aviv University
Phylogenetic diversity of bacteria and archea associated with the marine sponge, Suberitus ficus.

Grace Lim, Scripps Institute of Oceanography
Acyl homoserine lactone degrading marine bacteria: do they exist?

Claudia Lupp, University of Hawaii
Phages from Sippewissett salt marsh.

Adam Martiny, Technical University of Denmark
Metabolic interactions between a purple sulfur bacterium and a facultative anaerobe

Carl Pilcher, NASA
Iron metabolism in bacterial iron formations.

Brian Rash, University of Louisiana
Phylogenetic analysis of spirochetes in the Woods Hole area

Drew Reed, Rutgers University
Survey of α and β chitin degrading marine bacteria and archea from selected sites

Lasse Riemann, University of Copenhagen
Cultivability of marine pelagic bacteria under aerobic and anaerobic conditions.

Julie Robidart, Scripps Institute of Oceanography
Sulfate reduction in Sippewissett salt marsh: the oxic vs anoxic zone.

Martin Schuster, University of Iowa
Search for unusual chemolithotrophic life styles: oxidation of inorganic sulfur compounds coupled to manganese oxidation *AND Growth cycle and ixotrophy by Saprospira grandis.*

Rachel Whitaker, University of Calfornia, Berkeley
Formation of biofilms by purple nonsulfur bacteria.

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